CLAIMS

1. Method for estimating the seismic illumination fold $|(\bar{x},\bar{p})$ in the migrated 3D domain at at least one image point $\bar{x}$, for at least one dip of vector $\bar{p}$, wherein the illumination fold $I(\bar{x},\bar{p};\bar{s},\bar{r})$ for each (source $\bar{s}$, receiver $\bar{r}$) pair in the seismic survey is estimated, by applying the following steps:

- determination of the reflection travel time $t_r(\bar{x}_r(\bar{p});\bar{s},\bar{r})$ from the source $\bar{s}$ to the specular reflection point $\bar{x}_r$ on the plane reflector passing through the image point $\bar{x}$ and perpendicular to the dip vector $\bar{p}$ and then returning to the reflector $\bar{r}$;

starting from the diffraction travel time $t_d(\bar{x};\bar{s},\bar{r})$ from the source $\bar{s}$ to the said image point $\bar{x}$ and then returning to the reflector $\bar{r}$;

- incrementing the said illumination fold $I(\bar{x},\bar{p};\bar{s},\bar{r})$ related to the said (source $\bar{s}$, receiver $\bar{r}$) pair as a function of the difference between the diffraction travel time $t_d(\bar{x};\bar{s},\bar{r})$ and the reflection travel time $t_r(\bar{x}_r(\bar{p});\bar{s},\bar{r})$.

2. Method according to claim 1, comprising the step of summating each of the said illumination folds $I(\bar{x},\bar{p};\bar{s},\bar{r})$ related to a (source $\bar{s}$, receiver $\bar{r}$) pair so as to determine the total illumination fold $I(\bar{x},\bar{p}) = \sum_{\bar{s},\bar{p}} I(\bar{x},\bar{p};\bar{s},\bar{r})$.

3. Method according to one of the preceding claims, wherein, during the incrementing step, the illumination fold $I(\bar{x},\bar{p},\bar{s},\bar{r})$ is incremented using an increment function $i(t_d,t_r;\ \bar{s},\bar{r})$ according to $I(\bar{x},\bar{p}) = I(\bar{x},\bar{p}) + i(t_d,t_r;\ \bar{s},\bar{r})$, the said increment function taking account of the difference

between the diffraction travel time $t_d(\bar{x};\ \bar{s},\ \bar{r})$ and the reflection travel time $t_r(\bar{x}_r(\vec{p});\ \bar{s},\ \bar{r})$.

4. Method according to claim 3, wherein the increment function i is a function of the seismic wavelet s(t).

5. Method according to claim 4, wherein the increment function i is expressed as a function of the derivative of the seismic wavelet s(t) according to:

$$i(t_d,\ t_r;\ \bar{s},\ \bar{r}) = s(t_d(\bar{x};\ \bar{s},\ \bar{r}) - t_r(\bar{x}_r(\vec{p});\bar{s},\bar{r})$$

6. Method according to claim 4, wherein the increment function i is expressed as a function of the derivative $\bar{s}\,(t)$ of the seismic wavelet $s(t)$ with respect to time according to:

$$i(t_d,\ t_r;\ \bar{s},\ \bar{r}) = t_d(\bar{x};\ \bar{s},\ \bar{r}) - t_r(\bar{x}_r(\vec{p});\bar{s},\bar{r})$$

7. Method according to any one of claims 3 to 6, in which an a priori correction $w(\bar{x},\bar{s},\bar{r})$ of the illumination fold is taken into account by migration, comprising the step of incrementing the illumination fold $I(\bar{x},\bar{p};\bar{s},\bar{r})$ related to a (source $\bar{s}$, receiver $\bar{r}$) pair by $i(t_d,t_r;\bar{s},\bar{r}).w(\bar{x};\bar{s},\bar{r})$.

8. Method according to any one of the preceding claims, wherein the determination step includes the second order Taylor series development of the diffraction travel time $t_d(\bar{x};\bar{s},\bar{r})$ around the image point $\bar{x}$:

$$t_d(\bar{x};\bar{s},\bar{r})=t_d(\bar{x};\bar{s},\bar{r})+(\bar{\nabla}_x t_d(\bar{x};\bar{s},\bar{r}))^T.(\bar{x}_r-\bar{x})+\frac{1}{2}(\bar{x}_r-\bar{x})^T.\Delta_{x,x}t_d(\bar{x};\bar{s},\bar{r}).(\bar{x}_r-\bar{x})$$

9. Method according to claim 8, wherein the specular reflection point $\bar{x}_r(\bar{p})$ is determined along the length of the said reflector such that the diffraction travel time at the said specular reflection point $\bar{x}_r(\bar{p})$ is

stationary, according to the equation: $\bar{p}^T \wedge (\bar{\nabla}_x t_d(\bar{x};\bar{s},\bar{r}) + \Delta_{x,x} t_d(\bar{x};\bar{s},\bar{r}) \, . (\bar{x}_r(\bar{p}) - \bar{x})) = \bar{0}$.

10. Method according to any one of claims 8 or 9, wherein the specular reflection point $\bar{x}_r$ and the reflection travel time $t_r(\bar{x}_r(\bar{p});\bar{s},\bar{r})$ (are determined according to the following expressions:

$$\bar{x}_r(\bar{p}) = \bar{x} - M.F^{-1}.\ \bar{b}$$

$$t_r(\bar{x}_r(\bar{p});\bar{s},\bar{r}) = t_d(\bar{x};\bar{s},\bar{r}) - \frac{1}{2}.\bar{b}^r.\ F^{-1}.\ \bar{b}$$

where:

- M is a (3 x 2) matrix described by two vectors extending along the length of the reflector, and therefore perpendicular to the dip vector $\bar{p}$;

- $\bar{b}$ is a (2 x 1) vector of first order derivatives of the diffraction travel time along the reflection plane: $\bar{b} = M^T.(\bar{\nabla}_x t_d)$;

- F is a (2 x 2) matrix of second order derivatives of the diffraction travel time along the reflection plane: $F = M^T.(\Delta_{x,x} t_d).M$.

11. Method according to any one of the preceding claims, wherein the determination step uses isochronic migration maps $t_d(\bar{x};\bar{s},\bar{r})$ specified for each (source $\bar{s}$, receiver $\bar{r}$) pair involved in the migration at each image point $\bar{x}$ in the migrated 3D domain.

12. Method according to any one of the preceding claims, wherein the seismic illumination fold $I(\bar{x},\bar{p})$ in the migrated 3D domain is estimated during the Kirchhoff summation migration of seismic data recorded during the 3D seismic prospecting.

13. Method for correction of seismic data amplitudes recorded during 3D seismic prospecting in order to compensate for the effect of non-uniform illumination of sub-soil reflectors, comprising the steps of:

- estimating the illumination fold $I(\bar{x},\bar{p})$ using the method according to any one of claims 1 to 12,

- using the inverse $I^{-1}(\bar{x},\bar{p})$ of the said ratio as a weighting factor to be applied to each of the said seismic data amplitudes.

14. Method for selection of an acquisition geometry among a plurality of acquisition geometries as a function of the target of 3D seismic prospecting, comprising the steps of:

- determining the illumination fold $I(\bar{x},\bar{p})$ by the method according to any one of claims 1 to 12, for each of the acquisition geometries considered,

- selecting the acquisition geometry providing the optimum illumination fold as a function of the target.